PART I - ADMINISTRATIVE

Section 1. General administrative information

Title of project

Research/Evaluate Restoration Of Ne Ore Streams And Develop Mgmt Guidelines

BPA project number: 20102
Contract renewal date (mm/yyyy): ☐ **Multiple actions?**

Business name of agency, institution or organization requesting funding
Oregon State University and University of Oregon

Business acronym (if appropriate) OSU/UO

Proposal contact person or principal investigator:

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NPPC Program Measure Number(s) which this project addresses
Measure 205- Coordinated implemenatation monitoring and evaluation

FWS/NMFS Biological Opinion Number(s) which this project addresses

Other planning document references
This research project will help to elucidate many of the goals, as well as address the gaps in our knowledge of freshwater habitats specified in chapters 1, 2, 5, 8, 9, and 11 in Return to the River (ISG 1996).

We have worked closely with personnel of the Wallowa-Whitman, Umatilla, and Malheur National Forests and USFS-PNW Research station for > 10 years. Much of the work will be conducted on public lands under their managment. We have received a commitment from the WWNF (Paul Boehne) for assistance in project implemetation. In additon, we have contacted private landowners, other federal agencies, and Umatilla tribal specialists (Allen Childs) concerning this proposal. This research will also be conducted on private ranches where tribes, ODFW, and BPA have implemented restoration/habitat enhancement projects. All have given a positive response. As this is a research project, our actions on the ground are expected to have minimal influences or negative impacts on the resource.

Short description
Research/evaluate approaches to the restoration of freshwater salmon and riparian wildlife habitats. Quantify the biophysical responses of both passive and active restoration projects. Establish reference reaches of value for the normative river concept.

Target species

This proposal has relevance to the restoration of normative conditions of habitats for all resident and anadromous fishes in low order tributaries of the Columbia Basin as well as for riparian-dependent wildlife species

Section 2. Sorting and evaluation

Subbasin

Grande Ronde, John Day, Umatilla

Evaluation Process Sort

CBFWA caucus	Special evaluation process	ISRP project type
Mark one or more caucus	If your project fits either of these processes, mark one or both	Mark one or more categories
☒ Anadromous fish ☒ Resident fish ☒ Wildlife	☐ Multi-year (milestone-based evaluation) ☐ Watershed project evaluation	☐ Watershed councils/model watersheds ☒ Information dissemination ☐ Operation & maintenance ☐ New construction ☒ Research & monitoring ☐ Implementation & management ☐ Wildlife habitat acquisitions

Section 3. Relationships to other Bonneville projects

Umbrella / sub-proposal relationships. List umbrella project first.

Project #	Project title/description

Other dependent or critically-related projects

Project #	Project title/description	Nature of relationship
unkn?	Development of ecological approaches to restoration of fish habitats (FY98)	This has been an ongoing small research project examining riparian responses to restoration activities in the Upper Grande Ronde Basin. Much of the ground work for this proposal originated from the results of this project.

Section 4. Objectives, tasks and schedules

Past accomplishments

Year	Accomplishment	Met biological objectives?
	This is a new proposal	

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Characterize and quantify the biotic, geomorphic, and hydrologic processes and structural features of intact reference reaches. These reaches could then serve as potential goals (or endpoints) for restoration/enhancement activities.	a	Identify and establish permanent transects and sampling stations at intact stream reaches to serve as regional reference reaches
1		b	Measurements to describe the structure, function, and processes, of intact streams- hydrological, geomorphic and ecological. This includes descriptions of fish and invert communitires, riparain vegetation, stream channel and valley bottom characteristics.
2	Quantify the geomorphic, hydrologic, and biotic responses, and the rates and mechanisms of ecosystem change at sites undergoing: (a) passive restoration alone; and (b) sites with a combination of passive and active restoration approaches.	a	Measure the environmental effectiveness of projects in terms of restoring important fish habitat features and those components of the riparian/stream ecosystem that sustain fish habitat.
2		b	Measurements of environmental responses at project sites and evaluate their effectiveness based upon their hydrogeomorphic/stream channel configurations such as those developed by Rosgen (1994)
2		c	At restoration/enhancement sites, measure the changes in riparian vegetation that are important influences on fish habitat (cover, composistion, strucutre, nutrient inputs, water quality etc.,).
2		d	Measure geomorphological and hyrdrological processes and features important to fish-pools, depths, channel width, channel diversity, sediment retention, etc.,
2		e	Measure changes in the aquatic biota- fish and invertebrate assemblages
3	Based upon research results, develop management recommendations based upon these research results which can be used to predict which type of approaches will yield the highest probability of successful restoration of aquatic habitats.	a	Analysis of data to determine under which geomorphic, hydrologic, ecologic, and land management scenarios do various restoration approaches have the highest probability of success.

Objective schedules and costs

Obj #	Start date mm/yyyy	End date mm/yyyy	Measureable biological objective(s)	Milestone	FY2000 Cost %
1	10/1999	9/2000	Intact reference reaches described		20.00%
2	10/1999	9/2000	Restoration project research established; Initial responses described		.70
3	6/1999	9/2000	Intial recommendations formulated		.10
				Total	100.00%

Schedule constraints
There are no foreseeable constraints

Completion date
2004

Section 5. Budget

FY99 project budget (BPA obligated):

FY2000 budget by line item

Item	Note	% of total	FY2000
Personnel	Includes investigators, research associate, 6 grad students, summer field crews	%45	140884
Fringe benefits	varies depending upon position	%8	23787
Supplies, materials, non-expendable property	field equipment, computing supplies, lab costs, etc.,	%4	11,757
Operations & maintenance		%0	0
Capital acquisitions or improvements (e.g. land, buildings, major equip.)	Total station surveying instrument and accessories	%5	15000
NEPA costs		%0	0
Construction-related support		%0	0
PIT tags	# of tags:	%0	0
Travel	field work, per diem and travel to professional meetings	%5	16570
Indirect costs	43% on campus and 26% off campus	%22	67561
Subcontractor		%0	0
Other	Graduate student tuition	%11	34,377
		TOTAL BPA FY2000 BUDGET REQUEST	$309,936

Cost sharing

Organization	Item or service provided	% total project cost (incl. BPA)	Amount ($)
		%0	

		%0	
		%0	
		%0	
		Total project cost (including BPA portion)	$309,936

Outyear costs

	FY2001	FY02	FY03	FY04
Total budget	$326,249	$343,420	$361,495	$380,521

Section 6. References

Watershed?	Reference
☐	Austen, D.J., P.B. Bayley, and B.W. Menzel. 1994. Importance of the guild concept to fisheries research and management. Fisheries 19(6):12-20.
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☐	Case, R.L. and J. B. Kauffman. 1997. Wild ungulate influences on the recovery of willows, black cottonwood and thin-leaf alder following cessation of cattle grazing in Northeastern Oregon. Northwest Science 71:115-125.
☐	Ebersole, J.L., Liss, W.J., and Frissell, C.A., 1997. Restoraton of stream habitats in the western United States: restoration as reexpression of habitat capacity. Environmental Management 21: 1-14.
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☐	Hirsch, C.L. 1995. Seasonal shifts in rebind trout use of pools and their microhabitats in three central Oregon Streams. M.S. Thesis, Oregon State University, Corvallis, OR.
☐	Hokanson, K.E.F. 1977. Temperature requirements of some percids and adaptations to the seasonal temperature cycle. Journal of the Fisheries Research Board of Canada 34:1524-1550.
☐	Independent Scientific Group. 1996. Return to the Ri ver: Restoration of salmonid fishes in the Columbia River Ecosystem. Northwest Power Planning Council. Portland, OR
☐	Kauffman, J. B., W. C. Krueger and M. Vavra. 1983. Effects of late season cattle grazing on riparian plant communities. J. Range Manage. 36:685-691.
☐	Kauffman, J. B., W. C. Krueger and M. Vavra. 1985. Ecology and plant communities of the riparian area associated with Catherine Creek in northeastern Oregon. Oregon State Univ. Agr. Exp. Sta. Tech. Bull. 147. 35 p.
☐	Kauffman, J.B., R.L. Beschta, and W.S. Platts.1993. Fish habitat mprovement projects in the Fifteenmile Creek and Trout Creek Basins of central Oregon: Field review and management

	recommendations. BPA, Division of Fish and Wildlife, Portland, OR. DO
☐	Kauffman, J.B., R.L. Beschta, N. Otting, and D. Lytjen. 1997. An ecological perspective of riparian and stream restoration in the western United States. Fisheries 22(5):12-24.
☐	Li, H.W. and J.L. Li. 1996. Fish Community Composition. Pages 391-406 in F.R. Hauer and G.A. Lamberti (eds). Methods in stream ecology. Academic Press, N.Y., N.Y.
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☐	McDowell, P.F., and Magilligan, F.J., 1997b. Natural and management influences on pool development. Eos (Transactions of the Amer. Geophysical Union), Fall 1997 annual meeting, abstract.
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☐	U.S. Forest Service, 1996. Stream Inventory Handbook, Level I & II, Pacific Northwest Region, version 9.5. USDA Forest Service.
☐	

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PART II - NARRATIVE

Section 7. Abstract

While large expenditures have been spent on the recovery of native salmonids and their habitats in the interior Columbia Basin, a paucity of information exists on the site potential of riparian/stream ecosystems (i.e., the actual endpoint of the restoration). Restoration requires detailed understanding of the interactive biophysical attributes and processes that control the survival of salmonids (ISG 1996). We know little of the biophysical processes and patterns of recovery following the implementation of passive and active restoration. The specific outcome of this research study will be to provide fish and restoration managers with the information necessary to implement the most appropriate restoration approaches in the most appropriate reach types that will re-establish the biophysical processes necessary to create productive fish habitats. The overall objectives of this research will be met through two experiments: (1) quantify the biotic, hydrologic, and geomorphic characteristics of intact ecosystems; and (2) quantify the biophysical responses or patterns of recovery following the implementation of restoration activities. Specifically, we will quantify the rate and nature of hydrological, geomorphic, and ecological processes following passive restoration alone, and in combination with active restoration approaches. Both experiments will be conducted in a variety of stream reach types (gradient, elevation, stream order, floodplain width etc.,). A suite of restoration techniques will be examined (e.g., fencing, rechannelization, channel reconfiguration, instream structures, revegetation etc.,). We will quantify changes for the first five years following the implementation of restoration. Ecosystem changes will be compared with paired untreated (control) reaches as well as with intact reference reaches. This research will entail intensive field measurements of channel, stream, aquatic and vegetation characteristics annually.

Section 8. Project description

a. Technical and/or scientific background

Over $200 million has been spent on stream habitat improvement projects in the Columbia Basin. Although many restoration projects using a variety of different techniques have been constructed, almost no monitoring or evaluation of different restoration techniques has been done. The overall goal of this research project is to provide scientific evaluation of specific restoration approaches and recommendations for efficient use of resources in future restoration projects.

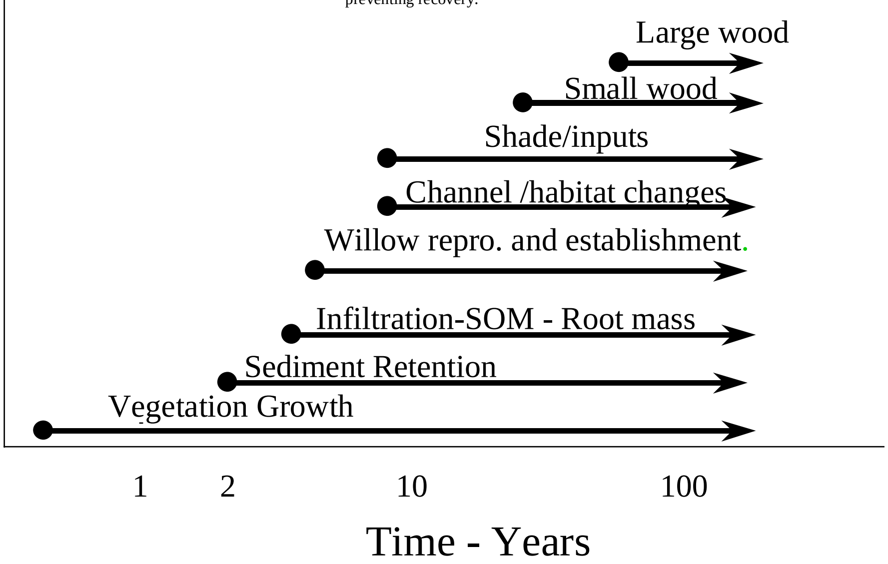
Recent critiques of stream restoration work have pointed out that many projects in the past were implemented with: 1) a lack of clear goals or objectives; 2) a lack of a firm and widely-understood scientific basis for restoration; 3) well-intentioned restoration objectives but approaches that actually resulted in habitat degradation; and 4) a lack of post-project evaluation and monitoring (ISG 1996; Ebersole, Liss and Frissell, 1997). This proposed research will address these shortcomings. Recently developed models of channel morphology show that different stream types have different characteristic dimensions (i.e., width:depth ratio), habitat qualities (i.e., pool frequency), and rates and processes of adjustment (Rosgen, 1996; Montgomery and Buffington, 1997). Similarly, the biotic responses vary according to soils, hydrology, climate and managerial regimes (Elmore and Kauffman 1994). Thus restoration goals should be stated in terms of optimum geomorphologic, ecological, and aquatic habitat standards for specific stream types and ecological communities. The research proposed here will help develop such standards by documenting geomorphologic, ecological and aquatic habitat conditions present at pristine or intact reference reaches. In addition, in this project we will quantitatively describe several restoration approaches by consistent repeated measurements. This monitoring can then be used to develop recommendations for future restoration projects.

All four investigators on this project have extensive experience in researching and evaluating stream restoration efforts. They have a long history of interdisciplinary cooperation with each other including a

NSF/EPA funded study in the John Day Basin to examine the geomorphic, hydrologic, and riparian connectivity to salmonids and their habitats. Beschta and Kauffman's evaluations of restoration projects have recommended a shift away from "hard" restoration techniques and use of non-native materials in restoration (Beschta, Platts and Kauffman, 1992; Kauffman Beschta and Platts 1993; Kauffman et al. 1997). Kauffman's research has focused on the basic ecology of riparian zones, influences of land use activities on riparian/floodplain functions, and ecological approaches to restoration. Beschta has conducted hydrological research in Oregon streams throughout the Pacific Northwest including numerous experiments in Northeast Oregon. These experiments have focused on stream temperature, channel morphology, ground water dynamics, and approaches to restoration. McDowell has conducted intensive field studies of geomorphologic adjustment of stream channels in grazing exclosures in eastern . McDowell is currently conducting a project with the Umatilla National Forest to evaluate effects of in-stream structures on channel morphology and effects of a large flood in 1996 on in-stream structures. Li has researched the ecology of native and exotic fishes of northeastern Oregon including responses to land use and restoration. Li et al. (1991, 1994) and Tait et al. (1994) evaluated the responses of native and exotic fishes of northeastern Oregon to anthropogenic influences including responses to installation of log weirs (the use of log weirs failed to significantly increase trout densities).

These previous research efforts have resulted in several key findings that underlie the research design proposed here. 1) Restoration of riparian/aquatic systems is most successful when it results in the facilitation of natural recovery processes; 2) Some characteristics (i.e., % vegetation cover, pool area) respond within a few years while other characteristics may take several decades to change (Case and Kauffman 1997; figure 1); 3) Although streams respond to management changes, the limits of response are clearly limited by the geomorphological range of each natural stream type (McDowell and Magilligan, 1997b); 4) Fish assemblages reflect the ecological state of the linkages between the floodplain and stream in that the riparian zones are the source of energy, nutrients, physical, and thermal environments in which

Figure 1. The recovery rates of selected leading edge and keystone features of salmonid habitats in the Interior Columbia Basin following the implementation of riparian buffers or restoration approaches that halt activities causing degradation or preventing recovery.



they depend (Li et al. 1994; Tait et al. 1994).

b. Rationale and significance to Regional Programs

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 indicated "The council shall properly develop and adopt...a program to protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat on the Columbia River and its tributaries." As a result, the Bonneville Power Administration (BPA) has spent millions of dollars on various instream projects throughout the Columbia Basin with the goal of increasing system-wide production of anadromous fisheries through a combination of habitat restoration and enhancement measures.

For over a decade, numerous BPA-funded projects have been initiated in the upper Columbia River Basin for the express intent of improving the aquatic habitats of anadromous salmonids. Largely missing from most of these projects has been any rigorous evaluation of project success or failure. Some field reviews of some habitat projects have been undertaken (e.g., Beschta et al. 1991, Kauffman et al. 1993) and provide an overview of major problems and opportunities associated with selected projects. However, there continues to be a lack of quantifiable information, collected in a systematic manner, that could be used as the basis for scientifically assessing the effects of individual projects on riparian/aquatic habitats, functions, or processes.

Recent publications (e.g., NRC 1992, ISG 1996, NRC 1996, Beschta 1997, and Kauffman et al. 1997) have identified and summarized important concepts associated with the restoration and improvement of aquatic ecosystems. While such conceptual approaches provide an important structure for those undertaking restoration efforts, there remains a paucity of basic information throughout the upper Columbia Basin on the hydrologic, geomorphic, and biologic responses that occur from various enhancement approaches. Basic data on the spatial and temporal responses of restoration approaches would provide: (1) a better understanding of project effects upon aquatic habitats and associated riparian functions; (2) a means of determining rates of aquatic habitat improvement; and (3) a basis for projecting future trends of habitat recovery.

The proposed research is intended to provide an improved understanding of both the effects and effectiveness of existing and proposed habitat enhancement projects in the upper Columbia River Basin. One component of the project will focus on systematically characterizing the hydrologic, geomorphic, and biotic functions and processes of relatively intact riparian/aquatic systems in northeastern Oregon (Figure 2). Characteristics of these "reference reaches" will not only provide improved insights for examining the extent that human activities have altered the processes and functions of other stream reaches, but will also serve as important benchmarks for establishing restoration goals in degraded reaches.

Another component of this project will address the initial rate of hydrologic, geomorphic, and biotic change associated with recently implemented enhancement/restoration projects. Such information represents an important element in understanding how these systems function and is almost entirely lacking for habitat projects in the upper Columbia basin. Similarly, quantitative assessments of previously implemented projects will be undertaken in this study to provide important insights into rates of change for a variety of riparian, channel, and habitat features.

It is expected that the proposed studies will provide an important scientific basis, currently lacking, for understanding the ecological principles of restoration/enhancement of sustainable aquatic habitats for salmonids. Thus, the results of this work are likely to have important ramifications for habitat improvement projects within and beyond the general geographic region of northeastern Oregon.

If sustainable and productive salmonid habitats are to be restored throughout the upper Columbia River Basin, additional efforts are needed to track the degree to which success, or failure, has been achieved and the degree to which restoration is attainable. Without such information, the substantial financial investments of the BPA (as well as Forest Service, BLM, and state agencies) for ecologically improving instream habitats will remain an unanswered question in the eyes of the scientific community, program administrators, and the public at large.

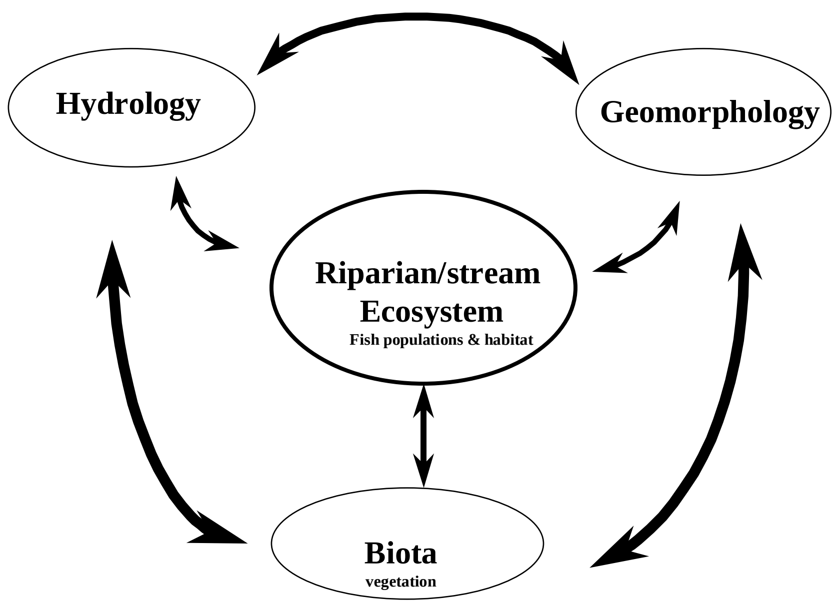


Figure 2. The relationships between the hydrologic, geomorphic, and biotic components of the riparian/stream ecosystem. The infinite number of linkages between them combine to influence the quality of fish habitats.

c. Relationships to other projects

This project represents a continuation of the riparian/stream/fisheries research that has been conducted by the principal investigators in Northeastern Oregon since 1990. Some of the previous research has been funded by the BPA (i.e., Evaluate Meadow Creek Instream structure and riparian restoration-BPA # 5519100 and Development of ecological approaches to restoration of fish habitats- FY 98 BPA project). In addition, the investigators have (and are) conducting a number studies in Northeast Oregon streams funded by the NSF, EPA, and the US Forest Service. These studies have focused on a variety of important issues pertaining to riparian/fish habitats. Specifically, much of the research has focused on fish ecology, riverine/riparian ecology, stream temperatures, the role of livestock on vegetation, soils and channel structure, and the relationships between hydrological, geomorphologic and vegetation features with the aquatic environment. However, this research will be the first of its kind to quantify the ecosystem processes and structural changes associated with actual restoration projects with the goal of providing valuable information on the proper approaches to successful restoration. Another submitted Fish and Wildlife proposal - Strategies for riparian recovery: plant succession & salmon; J Li principal investigator, is closely related to this project. At selected sites, this project will quantitatively describe natural ecosystem linkages between riparian zones and salmonids. If funded, these two OSU proposals would result in among the most productive and experienced riparian/stream restoration research teams in the world.

d. Project history (for ongoing projects)

This is a new proposal. However, the investigators all have a long history of successful research projects in Northeastern Oregon (see the technical and/or scientific background section).

e. Proposal objectives

Objectives

1. Characterize and quantify the biotic, geomorphic, and hydrologic processes and structural features of intact reference reaches. These sites would serve as potential goals (or endpoints) for restoration/enhancement activities. In other words, we hope to describe the biophysical processes and stricture that would define the normative river of these reach types.

2. At riparian/stream ecosystem restoration project sites in NE Oregon, establish long term studies to quantify the geomorphic, hydrologic, and biotic responses associated with restoration/management activities. This includes quantification of the rates and mechanisms of ecosystem response (structure and processes) at:
   (a) Sites undergoing passive restoration and;
   (b) Sites undergoing a combination of passive and active restoration activities.

3. Develop management recommendations based upon these research results which will move riverine habitats from their current state to a more normative state (i.e., which approaches have the highest probability of successful restoration of ecological processes consistent with the needs of native fish and wildlife species).

Hypotheses

1. The rate and magnitude of recovery of riparian/stream ecosystems is influenced by the approach to restoration, the inherent physical and biotic characteristics of the ecosystem, and the degree of anthropogenic degradation.

2. Initial changes in vegetation structure precipitate changes in geomorphology and hydrology that lead to the recovery of fish habitats. This includes such changes as sediment retention in the active channel (new bank and point bar formation), increased channel roughness, increases shade over the stream, increased allocthonous inputs, and increased interactions with the water column influencing quality.

3. Passive restoration (i.e., the cessation of those activities that are causing degradation or preventing recovery) is the most efficient and necessary first step in the to restoration of riparian/aquatic ecosystems where land use influences have arisen from out of the channel activities (i.e., logging, livestock grazing, agriculture, roads). Because of critical interactions of vegetation with hydrology and geomorphic processes, the initial recovery of riparian vegetation is a keystone leading edge process leading to the recovery of aquatic habitats.

4. The probability of success in projects that include active restoration (i.e., defined as the purposeful reconstruction of hydrologic, physical, geomorphic conditions and the biotic composition) is greatly influenced by prior and current land use management. The combination of active and passive restoration approaches will greatly accelerate recovery rates of fish and riparian complexity in the majority of stream ecosystem types.

5. Those restoration approaches that re-establish the biophysical processes that reconnect linkages between the aquatic ecosystems and their floodplain such as they exist in intact (pristine) streams will result in greater recovery of aquatic (fish) components than those that attempt to merely re-create form without function.

f. Methods

Experimental Layout and Study Areas

There are two strongly interrelated components of this proposal. The first component will entail the quantitative description of the most intact reference reaches available in Northeast Oregon (i.e., tributaries of the Grande Ronde, John Day, and Umatilla Rivers). A multidisciplinary scientific description of the most representative intact reaches will provide several important products for the resource manager or landowner. This entails an extremely detailed characterization of the hydrologic, geomorphic, and biotic (both plant communities and instream biota) features of functionally intact reaches. It will provide the best description to date on those sites where we should "protect the best". In addition, these results could provide the blueprint for enhancement activities in that the structure and function of these areas represent successful endpoints or targets of restoration. The intact reference reaches will be established in as wide of a variety of riverine systems and landscapes as possible (Table 1). Descriptions to be made in these reaches include intensive quantification of the channel morphology, water quality, riparian vegetation, soil structure and nutrient pools, and the aquatic fish and invertebrate assemblages.

The second component of this proposal entails a description of the biotic and physical changes that occur in disturbed reaches (from human causes) following the implementation of restoration activities. This includes comparisons with adjacent untreated reaches as well as the appropriate reference reaches. Measurements will be made on an annual basis starting at the initiation of restoration activities and continuing for at least 4 years. In the long term, these sites could serve as valuable reference reaches to monitor and evaluate changes into the future.

We will sample two approaches to restoration in Northeast Oregon. The first entails the responses to **passive restoration** (i.e., the cessation of those land use activities that are causing degradation or preventing recovery (Kauffman et al. 1997). This includes activities such as big game exclosures, corridor fencing, and rest from livestock grazing. However, it also includes the alterations of livestock management such that the ecosystem is recovering in a positive direction. These changes in land use management are common in order meet TMDL standards as well as restore habitats for anadromous and resident fish populations. This study will quantify the effectiveness in meeting water quality and habitat restoration goals. At least three sites will be established for permanent sampling. Each experimental site will include a treated reach, and an adjacent untreated control reach.

The second suite of restoration approaches to be examined includes the implementation of **active restoration**. This is defined as the purposeful reconstruction of hydrologic, physical, or geomorphic conditions; chemical clean up or adjustment of the environment; and biological manipulations including revegetation and the reintroduction of absent or nonviable native species following the implementation of passive restoration (Kauffman et al. 1997, NRC 1992). We will begin our research at the time of implementation of the channel manipulations and take measurements for a minimum of four additional years. Possible active manipulations to be examined include the placement of large wood debris into streams (whole pieces or as weirs, downstream V's etc.,), rechannelization, and channel reconfiguration. At each site, we will compare the treated reach with an adjacent untreated reach. Through time comparisons with the restoration activities will be made with appropriate reference reaches to gage the direction and magnitude of environmental change associated with the manipulations.

All data collection will be structured in terms of measuring "controlling characteristics" and "response characteristics". **Controlling characteristics** are biotic, hydrologic, and geomorphic characteristics that define the system and that control potential processes and rates of recovery. **Response characteristics** are those characteristics that reflect system status (ecological health) and degree of recovery. We will quantify the rates and processes of recovery following the implementation of restoration activities by measuring two types of response characteristics:

- **Leading-edge characteristics**: characteristics "that can be used to forecast or quantify the risk of future degradation [or future improvement] in a stream" (Pole et al. 1997). Leading-edge variables are the first indicators, characteristics that can adjust most rapidly. Leading edge variables include sediment retention, streambank vegetation growth, floodplain infiltration rates etc.

- **Keystone characteristics**: the most ecologically significant characteristics or features of the ecosystem. These are biotic, physical and climatic features that are most significant in terms of supporting sensitive species, biodiversity, ecological functions, or some other aspect of "ecological health". Keystone characteristics may have fast or slow adjustment rates. Keystone characteristics include streambank vegetation, large wood debris, salmonids, channel diversity, pool characteristics, temperature, flood regime, etc.,

In time-trend monitoring, it is imperative that the monitoring methods be quantitative, repeatable, transferable to different field personnel through unambiguous protocols, adequately precise to detect change, and should produce data suitable for statistical analysis (Poole, Frissell, and Ralph, 1997). We will use regular sampling strategies and will establish monumented measuring points for repeat measurement over.

Actual projects to be examined will be selected in cooperation with tribal and federal land managers as well as local watershed councils and private land owners. This cooperation will facilitate the selection of sites where scientifically valid comparisons of treated and untreated reaches can be made in "real world" situations. Quantification of changes in structure and processes in these reaches include channel morphology, sediment and nutrient retention, water quality, riparian vegetation, soil structure, nutrient pools, and the aquatic fish and invertebrate assemblages. Precise measurements are described in Table 2.

At each of the experimental restoration reaches, low level aerial photographs will be taken at the time of implementation. This will allow for the calculation of both floodplain and channel measurements at the start of the study. This includes such measures as detailed vegetation maps, channel sinuosity, channel width, floodplain area, and over channel cover. Locations of all measurements and permanent photo and sample points will be marked. The aerial photos will be shot again 5 years after implementation to quantify changes in the channel and floodplain. Copies of these photos and locations of important sampling features will be made available to the land managing entity as well as the BPA.

Table 1. Potential reference reaches for study of Northeast Oregon. Consultation with land managers, watershed councils and landowners of the region will be used to assist identification and selection of reference reaches.

Stream type	Potential reference reach
Low order Forested headwater-Rosgen Type B Channels	Upper Grande Ronde tributaries samples by Case (1995) and others
Low-order unconstrained meadow reaches Rosgen type C and E channels will be separated	W. Fk. Chicken Ck, Friday Meadows, Squaw Ck. (Grande Ronde), Upper tributaries of NFJD, reaches sampled by Magilligan and McDowell (1997) and others
Mid–order forested reaches-mostly B channels	N. Fk. Umatilla, N. Fk. Catherine Ck. and others
Mid-Order unconstrained reaches- mostly type C channels	Confluence of McCoy Ck and Meadow Ck (Tipperman Ranch) and others.
High order unconstrained and constrained reaches-mostly type C channels	North Fk John Day R., Wenaha R.

Table 2. Dependent response variables that will be measured at all reaches to be sampled in Northeastern Oregon Experimental stream sites. This includes restored reaches, adjacent untreated controls, and intact reference reaches.

Hydrogeomorphic	Vegetation/floodplain	Aquatic/water column
X-sections for width:depth ratio, entrenchment ratio	Abundance, biomass and composition within the active channel/bank full	Fish assemblages
Active Channel width/Bank full	Abundance, biomass, composition and structure in the floodplain	Invertebrate assemblages
% and area measurements of pools, riffles, glides, etc	Stream bank vegetation cover	Microhabitat Diversity
Pool frequency	Root biomass of stream banks	Redd counts
Streambank stability	Vegetation cover over channel	Water temperature
Pool length	Large wood debris	DOC, pH, Total N, P and NO_3
Pool depth	Soil organic matter	
Thalweg profiles	Soil bulk density	
Channel & floodplain roughness	Infiltration rates of floodplain	
Point bar/sediment accumulation	allocthonous inputs into the stream	
Streamflow dynamics-Frequency of overbank flows	Relationships of riparian vegetation composition to overbank flows	

Riparian vegetation and floodplain measurements

Riparian vegetation is a keystone ecosystem feature that has a strong influence on the quality of fish habitat. In addition, riparian zones are the most productive wildlife habitats in the Columbia Basin. In this sense, fisheries enhancement, wildlife habitat enhancement, and riparian vegetation recovery are one in the same. We hypothesize initial changes in vegetation structure precipitate changes in geomorphology and hydrology that lead to the recovery of fish habitats. This includes such changes as sediment retention in the active channel (new bank and point bar formation), increased channel roughness, increased shade over the stream, increased allocthonous inputs, and increased interactions with the water column influencing quality. This hypothesis will be addressed through measurement of changes in the composition, structure and mass of the riparian vegetation at all experimental reaches. Vegetation structure will be measured within the active channel (bank full) area, within the low flow area, and within the entire riparian zone.

At the floodplain level the vegetation composition of the entire floodplain will be mapped utilizing low-level aerial photos and extensive ground-truthing. Each vegetation stand will be identified and classified based upon the dominant species in each vegetation layer (i.e., tree, shrub and herb layers). Within each of the dominant plant community types changes in plant composition will be quantified through permanent transects where species frequency and mass will be measured. Ecosystem mass will be quantified as the sum of each stand area multiplied by the average mass of its community type. All vegetation measurements will follow that of Case (1995) for mass, and Kauffman et al. (1983, 1985) and Lytjen (1998) for composition and diversity. Changes in soil properties through time (bulk density, porosity infiltration rates, and soil organic matter) will be measured. Methods follow that of Brady (1974).

To test the hypotheses of restoration, measurements of the change in vegetation composition will strongly focus on those changes that occur in the active channel areas. This is where we predict that the greatest and most immediate interactions between vegetation, hydrology, geomorphology and the aquatic biota occur. This includes the area of below bankfull (active channel) and within the base flow channel. The area of the active channel will be measured at each reach through measurement of channel area during peak flow each year. Measurements of the area occupied during peak flow will be made in conjunction with hydrological and geomorphologic measurements made at this time. Total vegetation biomass within the active channel will be measured annually at the end of the growing season (but prior to peak flow and snowfall). This has been found to accurately quantify the quantity of vegetation biomass that interacts with peak flows during the early spring/winter months

Herbaceous vegetation biomass will be quantified through destructive sampling of ≥ 30 25 X 25 cm microplots following the methods outlined in Kauffman et al. 1984. Changes in shrub wood vegetation structure will follow that of Case (1995) and Case and Kauffman (1997). Density and structure of woody vegetation will be quantified through annual measurement of shrub density in permanently marked 2 X 25-m plots. Within each plot shrub density (by species) and structural features (crown area, stem density, diameter and height) will be measured. These are parameters necessary to quantify the vegetation contribution to channel roughness. The abundance and composition of dead and downed wood will follow that of Case (1995). All wood pieces (natural and placed will be measured and mapped in each reach annually. Streambank root biomass which has multiple functional roles in soil retention, nutrient cycles, and aquatic structure will be quantified at each site annually through quantification of mass contained in cores to a depth of 40cm following the methods of Kauffman et al. (1998). At least 10 cores per site will be excavated to quantify root biomass. The entire soil root core will be transported to the lab where roots will be extracted via an automated root washer. Annual changes in ecosystem parameters will be tested using a variety of uni- and multivariate statistical methods. Statistical tests will be preformed comparing the changes between the treated areas and the adjacent controls and where possible between areas treated with passive vs. active restoration approaches. Also, comparisons will be made between the restoration reaches and the intact reference reaches.

Hydrological/Geomorphologic Methods

While hydrologic disturbance regimes undoubtedly play an important role in the ultimate character of various stream reaches, the relatively short time frame of this project precludes long-term monitoring of hydrologic processes. Thus, detailed information will be collected at each of the selected stream reaches to characterize the hydrogeomorphic status of the reach.

Initially, each reach will be spatially referenced with a GPS system; furthermore each end of a selected reach will be monumented in the field. The length of reach utilized for intensive measurements will vary (larger streams having longer reach lengths) but will always be at least 100 m in length. In general, sample reaches will be at least 40 to 50 active channel widths (ACWs) in length. Stream discharge will be determined at each sample reach for the date of channel morphology measurements. Staff gages will be installed to allow tracking of summertime stages and flows; crest gages will also be installed at each site to establish the upper levels of flow during the period of study.

We aim to measure channel morphology in ways that capture both cross-section dimensions and downstream patterns of bed morphology We will measure channel dimensions (width, depth) using a regular sampling strategy downstream through the study reach, with measurements taken at intervals of 0.5 bankfull width or less. We will establish cross-sections with permanent survey markers, for repeat survey (Harrelson, Rawlins, and Potyondy, 1994). We will describe and measure channel bed morphology and channel unit assemblages, modifying standard procedures (USFS 1996; Moore, Jones and Dambacher, 1997; Bisson and Montgomery, 1996; Platts et al., 1987) so that results are repeatable and transferable. Channel unit dimensions will be directly measured rather than estimated. Additionally, we will define unit boundaries using explicit criteria based on bed inflection points rather than water surface characteristics or inferred hydraulic characteristics. Size and quality of bed material will be measured using the Wolman pebble count method including counting of fines.

Many channels become over-enlarged through bank destabilization, widening and/or incision. The result is loss of channel-floodplain interaction because overbank flooding becomes very rare. We will evaluate channel over-enlargement and loss of channel floodplain connection through the entrenchment index (Rosgen, 1996) and by quantitative comparison of channel capacity to estimated annual peak discharge (Thorne Allen and Simon, 1996).

In addition, more detailed measurements of channel morphology will be conducted along each reach to provide important insights into the "structure" of pools and riffles and cross-section changes over time. At locations spaced approximately 1/4 to 1/3 of the ACW along the channel, a variety of measurements will be obtained. Thus, at least 100, and generally more, detailed channel measurements will be obtained at each site. These measurements will include thalweg depth, wetted width, active channel width, and proportion of each bank that is actively eroding. In addition, the elevation of near-channel geomorphic surfaces (i.e., floodplains, and terraces) will be obtained for each 5th measurement point along the channel. Riparian vegetation will be described for the near-channel margins (see methodology for riparian vegetation).

Detailed morphology measurements uniformly spaced along the channel are necessary to help assess not only the current status of a channel, but also for documenting any physical changes in channel morphology that occur (a) naturally or as a result of (b) enhancement projects. From these measurements, changes in mean characteristics (e.g., mean depths, mean pool/riffle ratios, mean width:depth ratios) and variances will be determined. In addition, because of the high spatial density of measurements at a uniform spacing along a reach, time-series analytical techniques will be used to characterize the spatial "structure" of channel dimensions (e.g., depths, and widths). Autocorrelation techniques will be used to distinguish changes in pool/riffle features over time. Width:depth ratios and the frequency and morphology of pools will be of particular interest in these analyses.

Many of the stream reaches in northeastern Oregon have experienced the effects of grazing from domestic and wild ungulates. Where enhancement projects have removed grazing pressure and riparian vegetation is expected to recover, measurements of channel "roughness" will be undertaken. These measurements will occur over a range of flows that occur within the active channel (i.e., generally below bankfull). Channel roughness (Manning's n) will be calculated from detailed cross-section measurements and discharge measurements for specific flow levels at the beginning of an enhancement project. These measurements will be repeated after several years of vegetation recovery to establish the extent of change in this important hydraulic parameter. Channel roughness measurements will also be undertaken for sites chosen as reference reaches.

The primary level of observation and statistical comparison for channel characteristics, vegetation response characteristics, and aquatic population and habitat characteristics will be the reach. We will calculate reach-average values for each characteristic, and compare these values to reach-average values for reference reaches and other standards. For some characteristics, we will also analyze and compare individual transects or cross-sections. We will stratify sites so that comparisons of channel adjustment are made among sites with similar morphology and adjustment processes. Sites will be stratified using basic stream characteristics such as drainage area, channel slope, bed material type, and channel type (Rosgen, 1994, 1996; Montgomery and Buffington 1996; Bisson and Montgomery 1996).

Aquatic Biotic Assemblages

We will use reaches 40 channel widths in length to sample aquatic fauna within the study sites. This has been determined to be of a sufficient length to capture the representative habitats at the scale of stream reach and therefore to assess the species composition of streams (Lou Reynolds and Stan Gregory, personal communication; Lyons 1992). We will follow the Suggestion of Austen et al. (1994) to characterize the fauna as comprising several guilds. They suggest that guilds detect environmental change more precisely because guilds exhibit the characteristics of a super-species. Therefore guild membership in different habitats provides superior information concerning that habitat.

For instance, highly sensitive, resident fishes such as bull trout, west slope cutthroat trout or exotic brook trout can be used as surrogates for anadromous salmonids where underseeded drainages are impacted by migration barriers. Fish assemblages will be categorized into different temperature and habitat guilds according to the classification of Hokanson (1977) and Herbold and Moyle (1987). These will comprise the following categories coldwater midwater assemblage (bull trout, inland rainbow trout, spring chinook salmon), warmwater midwater assemblage (redside shiner, northern squawfish), coolwater benthic assemblage (mountain whitefish, torrent sculpin, Piute sculpin, longnose dace, mountain sucker, lamprey ammocoetes) and warmwater benthic assemblage (chiselmouth, speckled dace, bridgelip sucker, largescale sucker).

We will use Merritt and Cummins (1984) functional groups for classifying invertebrates, i.e., shredders, borers, grazers, filterers, collectors; aspects that reflect the status and composition of nearby riparian vegetation. Species composition data will be gathered according to the methods of Li et al. (1994). Species in pools will be estimated by snorkeling censuses; whereas riffles will be estimated by electroshocking. Calibration of both gears to a common method, mark and recapture estimates, will be conducted. Invertebrates will be sampled in riffles using a Hess sampler according to the procedures of Tacit et al. (1994). Sample sites will be go-referenced with G.P.S.

We will determine species richness of each assemblage type within habitat units of each stream reach sampled. We will follow the methods of Li and Li (1996) for analyzing fish community composition and Tait et al. (1994) for characterizing the invertebrate communities. We will use Margalefs Index to analyze species richness patterns within communities:

$D_{mg} = (S-1)/\ln n$

where S = total number of taxa in the sample, and ln is the natural log of the total numbers of individuals. We will use the Morasita-Horn index to examine paired differences between communities:

$C_{MH} = [2*3 (an_i bn_i)]/[da + db) aN *bN]$

where aN is the number of individuals in site A; bN, the numbers in site B; an_i is the number of individuals of species I in site A; bn_i is the number of individuals of species I in site B.

Microhabitat Complexity and Diversity*:* This will be used to examine the relationship of channel structure to fish habitat quality. We will randomly select 20% of the habitats within each study reach to map. We will use the methods of Hirsch (1995) to index complexity, essentially a measurement of bathymetric development and use her typological approach to identify microhabitats. Diversity will be recorded using the Shannon-Weiner Index where proportions of microhabitat habitat area are used in the calculations. As each unit will have been biologically censused, we can correlate standing crops and species richness with indices of complexity and diversity.

Redd counts: Infiltration rates of floodplains should be correlated to higher quality conditions for redds and correspond with redd densities. We will conduct redd counts during the spring for steelhead/redband trout and during the fall for bull trout and spring chinook salmon. This will be done with consultation of the responsible district biologists. Correlations of infiltration rates on redd densities will be examined.

g. Facilities and equipment

There will be adequate facilities and equipment to conduct all facets of this proposed research study. We have excellent laboratory and computing facilities for conducting the necessary analysis of this project. All soil, water, and vegetation laboratory analyses can be conducted on state-of –the-art instruments at OSU. Field equipment are largely already in possession of the investigators with the exception of a total station surveying instrument and necessary accessories. This equipment will allow for accurate assessment of geomorphic/hydrologic changes that may occur with restoration efforts or natural disturbance events.

All vehicles utilized will be from the State of Oregon Motor Pool.

h. Budget

Budget Justification.

Salaries include Kauffman (PI) 2 mon/yr, MacDowell (1 mon/yr) and Beschta (1 mon/yr). Also, salaries are requested for one full time post-doctoral research associate. We request funds for 6 graduate students, their tuition, and summer wages. This large and well-trained labor force is needed given the labor-intensive nature of the proposed project. This includes work in field locations, laboratory, and computer analyses.

Fringe benefits range from 35-40% of the investigator's salaries and are 48% for the post-doc. Fringe benefits for graduate students are 1% during the school year and 5% during summer months. Undergraduate summer fringe benefits are also 5%.

We request funds for field supplies including aerial photos, field equipment for fish, soils, vegetation, geomorphic, and hydrologic sampling. This includes equipment such as tape measures, GPS, plot frames, cameras, film, electro-shockers, nets, litter traps, stadia rods, compasses, clinometers, densiometers, etc.

Computer supplies includes PC's, software, and paper. Laboratory supplies includes those necessary for the analysis of soil and plant samples for carbon, nitrogen, pH etc.,

Most of the expensive equipment and laboratory facilities will supplied by OSU or the U of O. The only equipment requested is the total station survey equipment necessary for accurate establishment and measurement of hydrological and geomorphic characteristics at permanent sampling sites.

Travel funds are requested for the extensive amount required to conduct this research project. Travel includes vehicle rental and per diem, while in the field. In addition, travel is requested for the establishment of workshops, symposia and other opportunities that will allow investigators to disseminate information to fisheries, wildlife, and other land managers.

The indirect costs (overhead) at OSU are 43% on-campus and 26% off-campus. These charges are similar to, or less, than those charged by other major research Universities in the USA.

Section 9. Key personnel

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EDUCATION

Ph.D. 1986 University of California, Berkeley. Wildland Resource Science/Forest Ecology
M.S. 1982 Oregon State University, Corvallis. Rangeland Resources
B.S. 1978 Texas Tech University, Lubbock. Range and Wildlife Science

EMPLOYMENT

6/1995-present - Associate Professor Dept. of Fisheries and Wildlife, Oregon State University. Teaching and Research: Habitat, disturbance, and ecosystem ecology of riparian ecosystems - ecosystem dynamics and influences of disturbances on biological diversity, biogeochemistry, and site productivity in tropical and temperate ecosystems.

3/1986-6/1995 - Associate Professor (1991), Assistant Professor (1986-1991), Dept. of Rangeland Resources, Oregon State University. Teaching and Research: Riparian Ecology, Fire Ecology, and Disturbance ecology.

EXPERTISE

Dr. Kauffman has been conducting research in riparian zone ecology for 20 years. Most of that research has been in Northeast Oregon. He also currently teaches the wetlands and riparian ecology course at OSU. Research has focused on the plant ecology, biogeochemistry, and floodplain/stream interactions. His research has largely been applied in nature with an emphasis on restoration ecology and how land use influences the dynamics of riparian/stream ecosystems. Dr. Kauffman has authored over 100 scientific papers including 40 refereed journal articles and 11 book chapters.

SELECTED PUBLICATIONS

Elmore, W. and J. B. Kauffman. 1994. Riparian and watershed systems: Degradation and restoration. pp. 212-232. IN: Vavra, M., W. A. Laycock and R. D. Pieper (eds.). Ecological Implications of Livestock Herbivory in the West. Society for Range Management, Denver, CO.

Green, D. M. and J. B. Kauffman. 1995. Succession and livestock grazing in a northeastern Oregon riparian ecosystem. J. Range Management. 48:307-313.

Kauffman, J.B., N. Otting, D. Lytjen, and R.L. Beschta. 1996 Ecological Principles and approaches to riparian restoration in the Western United States. In: Healing the rivers. Pacific Rivers Council Eugene, OR.

Kauffman, J. B., R. L. Beschta, N. Otting, and D. Lytjen. 1997. An ecological perspective of riparian and stream restoration in the western United States. Fisheries 22:12-24.

Case, R.L. and J. B. Kauffman. 1997. Wild ungulate influences on the recovery of willows, black cottonwood and thin-leaf alder following cessation of cattle grazing in Northeastern Oregon. Northwest Science 71:115-125.

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Professor of Forest Hydrology 0.25 FTE
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EDUCATION

Ph.D. 1974 University of Arizona. Watershed Management/Hydrology
M.S. 1967 Utah State University. Forest Hydrology
B.S. 1965 Colorado State University. Forest Management

EMPLOYMENT

12/1974-present - Professor (1987-present), Acting Department Head (1987), Associate Professor (1980-86), Assistant Professor (1974-80), Department of Forest Engineering, Oregon State University. Teaching: Watershed Processes and Management, Forest Land Use and Water Quality, Snow Hydrology. Research: Sediment transport in mountain streams, role of riparian vegetation on stream temperatures and channel morphology, subsurface flow in riparian areas, hydrology of wetlands, and others.

EXPERTISE

Dr. Beschta has been conducting research on forest and range watersheds in the Pacific Northwest for over 20 years. In 1982, he undertook a Sabbatical with the University of Canterbury in New Zealand. He has served as Academic Vice President for the American Institute of Hydrology, as a member of the National Research Council committee on protection and management of Pacific Northwest Anadromous Salmonids, and has participated in scientific advisory teams for the governor (e.g., forest health of eastside forests and landslides in western Oregon). Dr. Beschta has been a co-organizer of several major Pacific Northwest symposiums on riparian management, erosion, and sedimentation; he has also taught in various workshops and shortcourses (e.g., precipitation and runoff of mountainous watersheds, effects of vegetation on the hydrology of riparian areas and channel morphology, water quality monitoring, hydrology of wetlands and riparian areas, and others. Over the last 15 years, Dr. Beschta has authored or co-authored over 70 publications related to the hydrology of forest and range watersheds. He is a Certified Professional Hydrologist (#317) of the American Institute of Hydrology.

SELECTED PUBLICATIONS

Hill, M.T., W.S. Platts, and R.L. Beschta. 1991. Ecological and geomorphological concepts for instream and out-of-channel flow requirements. Rivers 2(3):198-210.

Sedell, J.R., and R.L. Beschta. 1991. Bringing back the "Bio" in bioengineering. American Fisheries Society Symposium 10:160-175.

Beschta, R.L. and 15 others. 1996. Upstream: Salmon and society in the Pacific Northwest. National Research Council, National Academy Press, Washington, D.C. 452 pp.

Beschta, R.L. 1997. Restoration of riparian and aquatic systems for improved aquatic habitats in the upper Columbia River Basin. Pp. 475-491. IN: D.G. Stouter, P.A. Bisson, and R.J. Naiman (eds). Pacific Salmon and their Ecosystems: Status and Future Options. Chapman and Hall, New York.

Kauffman, J.B., R.L. Beschta, N. Otting, and D. Lytjen. 1997. An ecological perspective of riparian and stream restoration in the western United States. Fisheries 22(5):12-24.

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Degrees Earned:

Ph.D. (Geography), May 1980, University of Wisconsin, Madison, Wisconsin
M.C.R.P. (Environmental Planning), May 1977, Illinois Institute of Technology, Chicago, Illinois
B. Arch., May 1971, Illinois Institute of Technology, Chicago, Illinois

Current Employment:

Professor, Department of Geography, University of Oregon

Duties: Teaching (Geomorphology, Fluvial geomorphology) and Research

Employment History and Other Professional Activities:

Assistant Professor to Professor, Department of Geography, University of Oregon, 1982-present
Head, Department of Geography, University of Oregon, 1993-96
Associate Vice President for Research, University of Oregon, 1990-92.
Member, Board of Directors, Oregon Water Resources Research Institute, 1991-94.
Chair, Geomorphology Specialty Group, Association of American Geographers, 1990-91.
Member, State of Oregon Governor's Watershed Enhancement Board Advisory Committee, 1987-90.

Expertise: Directed a research project "Processes and Timing of Hydraulic and Geomorphic Adjustments during Stream Channel Recovery," on stream channel response to elimination of cattle grazing pressure in eastern Oregon, 1993-97, funded by NSF. Co-PI on a multidisciplinary project, "Hydrological, geomorphic and ecological connectivity in Columbia River watersheds" (funded by EPA Water and Watersheds program, 1996-99), with responsibility for analysis of geomorphic and geologic controls of stream temperatures. Conducted research funded by the Umatilla and Malheur National Forests on stream channel geomorphic conditions and processes. Extensive experience in field survey, analysis of channel unit and stream inventory data, soil and sediment analysis, GIS analysis, and aerial imagery interpretation.

Selected Research Publications:

"Stream channel adjustment following elimination of cattle grazing," F. J. Magilligan and P. F. McDowell, Journal of the American Water Resources Association (formerly Water Resources Bulletin) 33: 867-878 (1997).

"Response and recovery of stream channels following removal of cattle grazing," P. F. McDowell and F. J. Magilligan, in Wang, S.S. Y., Langendoen, E.J., and Shields, F.D., Jr., eds., Management of Landscapes Disturbed by Channel Incision: Stabilization, Rehabilitation, Restoration, p. 469-475. Oxford Mississippi: University of Mississippi, (1997).

"Long-term environmental change," P. McDowell, T. Webb III, and P. Bartlein, in The Earth as Transformed by Human Action, B. L. Turner and others, eds., p. 143-162, Cambridge University Press, (1990). Also reprinted in Ecological Time Series, T. M. Powell and J. H. Steele, eds., Chapman and Hall (1995).

"Geomorphic Processes in the Pacific Coast and Mountain System of Oregon and Washington," in Geomorphic Systems of North America, W. Graf, ed., Geological Society of North America, Decade of North American Geology series, Centennial Special Volume 2, p. 539-549 (1987).

"Evidence of stream response to Holocene climatic change in a small Wisconsin watershed," Quaternary Research 19: 100-116 (1983).

HIRAM W. LI

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EDUCATION:
A.B. - Zoology, University of California, Berkeley, 1966; **M.S. - Fishery and Wildlife Biology**, Colorado State University, 1973; **Ph.D.- Ecology,** University of California, Davis, 1973
EXPERIENCE:

Professor and Assistant Leader, Oregon Cooperative Fishery Unit, Department of Fisheries and Wildlife, Oregon State University. 1988-Present; **Associate Professor and Assistant Leader**, Oregon Cooperative Fishery Unit, Department of Fisheries and Wildlife, Oregon State University. 1979 to 1988; **Assistant Professor**, Department of Wildlife and Fisheries, University of California, Davis. July 1973 to January 1979.

PROFESSIONAL ACTIVITIES:

Ecology Advisory Panel for the National Science Foundation 1984-1987; **Associate Editor** for Transactions of the American Fisheries Society 1986-1988; **Foley-Hatfield Congressional Team** on Eastside Forest Health Assessment, 1992-1993; **Referee** for 14 primary journals

HONORS AND AWARDS:

Commendation Award, Sport Fishing Institute (1978); **Quality Performance Awards,** U.S. Fish and Wildlife Service (1982, 1989, 1990, 1991); **Director's Research Excellence Award**, U.S. Fish and Wildlife Service
(1991); **Special Achievement Award**, U.S. Fish and Wildlife Service (1992, 1993, 1994); **Outstanding Group Achievement Award, American Institute of Fishery Research Biologists** (awarded to the Cooperative Fish and Wildlife Research Units) (1992)

PUBLICATIONS: 30 refereed papers in Primary Journals, 10 Book Chapters, 30 Technical reports.

FIVE PUBLICATIONS RELATED TO THIS PROPOSAL :

Li, H.W., G.A. Lamberti, T.N. Pearsons, C.K. Tait, J.L. Li. 1994. Cumulative impact of riparian disturbance in small streams of the John Day Basin, Oregon. Transactions of the American Fisheries Society 123(4):627-640.

Bayley, P.B. and H.W. Li. 1992. Riverine Fishes. Chapter 12. Pages 251-281 in P. Calow, G.E. Petts (eds.). The Rivers Handbook, Hydrological and Ecological, Volume 1. Blackwell Scientific.

Tait, C.K., J.L. Li, G.A. Lamberti, T.N. Pearsons, and H.W. Li. 1994. Relationships between riparian cover and the community structure of high desert streams. Journal of the North American Benthological Society 13(1):45-56.

Li, H.W. and J.L. Li. 1996. Fish Community Composition. Pages 391-406 *in* F.R. Hauer and G.A. Lamberti (eds). Methods in stream ecology. Academic Press, N.Y., N.Y.

Torgersen, C.E., D. Price, H.W. Li and B.A. McIntosh. 1999. Multiscale thermal refugia and stream habitat associations of chinook salmon in northeastern Oregon. Ecological Applications (*In Press)*.

Section 10. Information/technology transfer

There will be a number of refereed journal articles that arise out of this research. Papers will be published in ecological, hydrological, geomorphic, fisheries and river management oriented journals. In addition, we expect that 6 graduate theses/dissertations would result from this research. Annually, a number of professional presentations would be made at workshops and symposia. In addition, the investigators will regularly deliver seminars of research results for land managers and the interested public in Northeastern Oregon and other parts within the Pacific Northwest. Applied, on the ground demonstrations and workshops will also be offered in NE Oregon (SE Washington). The consultation and dissemination of information to land management agencies, tribes, private landowners and the interested public are a major responsibility of the University Professors involved in this research.

Congratulations!